



# National Institute of Standards & Technology

## Certificate of Analysis

Standard Reference Material<sup>®</sup> 3159

Thorium Standard Solution

Lot No. 992912

This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of Thorium. One unit of SRM 3159 consists of 50 mL of a single element solution in a high density polyethylene bottle sealed in an aluminized bag. The solution was prepared gravimetrically from thorium oxide to contain a known mass fraction of Thorium. The solution contains nitric acid at a volume fraction of approximately 10 %.

Certified Value of Thorium: 9.98 mg/g  $\pm$  0.04 mg/g

The certified value is based on inductively coupled plasma optical emission spectrometry (ICP-OES) using four independently prepared primary standards made from high purity thorium metal. *No correction has been applied for transpiration that will occur after the SRM bottle unit has been removed from the sealed bag.* See "Instructions for Use" for more information regarding transpiration.

The uncertainty in the certified value is calculated as

$$U = ku_c$$

where  $k = 2$  is the coverage factor for a 95 % confidence interval. The quantity  $u_c$  is the combined standard uncertainty calculated according to the "ISO Guide" [1]. The value of  $u_c$  is intended to represent, at the level of one standard deviation, the combined effect of uncertainty components associated with the gravimetric preparation, the ICP-OES determination, and method bias [2].

**Expiration of Certification:** The certification of **SRM 3159 Lot No. 992912** is valid, within the measurement uncertainty specified, until **30 November 2008**, provided the SRM is handled in accordance with instructions given in this certificate. See "Instructions for Use". This certification is nullified if the SRM is damaged, contaminated, or modified.

Coordination of the technical measurements leading to the certification of SRM 3159 was provided by G.C. Turk of the NIST Analytical Chemistry Division.

This SRM was prepared by T.A. Butler of the NIST Analytical Chemistry Division. The ICP-OES analysis was performed by M.L. Salit and A.P. Lindstrom. Primary standards for ICP-OES calibration were prepared by B.R. Norman and C.M. Beck II of the NIST Analytical Chemistry Division.

Statistical consultation was provided by S.D. Leigh of the NIST Statistical Engineering Division.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by C.S. Davis of the NIST Measurement Services Division.

Willie E. May, Chief  
Analytical Chemistry Division

John Rumble, Jr., Chief  
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Gaithersburg, MD 20899  
Certificate Issue Date: 22 December 2003  
*See Certificate Revision History on Last Page*

**Maintenance of Certification:** NIST will monitor representative solutions from this SRM lot over the period of its certification. If substantive changes occur that affect the certification before the expiration of certification, NIST will notify the purchaser. Return of the attached registration card will facilitate notification.

## TRACEABILITY TO THIS SRM

Calibration of analytical instruments or procedures for the determination of Thorium should be performed using standards that are traceable to this SRM. The traceability of standards to this SRM must be established through an unbroken chain of comparisons, each having stated uncertainties [3]. Comparisons are based on physical or chemical measurements proportional to thorium concentration. These may include various spectroscopic or classical methods of analysis. Gravimetric or volumetric dilution is also a method of comparison, where the mass or volume of a solution before and after dilution is measured. The uncertainties assigned to such traceable standards must include the uncertainty of this SRM appropriately combined with the uncertainties of all comparison measurements.

## INSTRUCTIONS FOR USE

This SRM can be used to prepare *working standard solutions* in the range of 10 mg/kg to 100 mg/kg, from which more dilute standards are prepared. The user should establish internal laboratory procedures that specify a maximum shelf-life for a *working standard solution*. Two procedures for the preparation of working standard solutions follow.

**Preparation of Working Standard Solutions by Mass:** Each working standard solution should be prepared by transferring an aliquot of the SRM to an empty, dry, preweighed polyethylene bottle and then reweighing the bottle. An appropriate dilute acid must be added by mass to bring the solution to the approximate desired dilution. The dilution need not be exact since the mass of the empty bottle, mass of the bottle plus SRM aliquot, and the final diluted mass of the solution will permit calculation of the exact concentration of the working solution. Dilutions prepared gravimetrically as described will need no correction for temperature and no further correction for true concentration in vacuum. The working standard solution concentration will be in mg/kg units. Volumetric dilutions are **NOT** recommended due to uncertainties in volume calibrations and variations in density. However, for user convenience, a procedure for volumetric preparation that will minimize the major sources of error is given below.

**Preparation of Working Standard Solutions by Volume:** Each working standard solution should be prepared by transferring an aliquot of the SRM to an empty, dry polyethylene bottle and then weighing the bottle. The solution must now be transferred to a Class A volumetric flask and the polyethylene bottle reweighed to determine the exact mass of SRM solution transferred. The solution in the flask is then diluted to 99 % + of volume using an appropriate dilute acid, mixed thoroughly, and the remaining few drops needed to dilute to exact volume, carefully added. The concentration (in mg/mL) of the resulting working standard solution can then be calculated by multiplying the mass (in g) of the SRM solution amount by the SRM certified value (in mg/g) and dividing the numerical product by the calibrated volume (in mL) of the flask used for dilution. Thus, no correction for density is needed, and although the concentration of the resulting working standard solution may be an uneven fraction of the original SRM concentration, it will be known as accurately as a volumetric dilution permits.

**Transpiration:** While stored in the aluminized bag, transpiration of this SRM is negligible. After the SRM has been removed from the aluminized bag, transpiration will occur at a rate of approximately 0.2 % relative per year, resulting in a gradual increase in the element mass fraction. It is the responsibility of the user to account for this effect. The recommended way to reduce the effects of transpiration is to begin the preparation of all working standard solutions by delivering weighed aliquots of the SRM to appropriate vessels as soon as the SRM is removed from the aluminized bag. The aliquots may be stored and can be diluted to known mass or volume at a later date. Storage of a partially used SRM bottle is **NOT** recommended; however, if such storage is necessary, the cap should be tightly sealed and the SRM bottle kept in an airtight container to slow the rate of transpiration. When the bottle is weighed both before and after being placed in storage, the mass difference observed will be a measure of transpiration mass loss. The user should set a maximum shelf-life for a *partially used SRM bottle* commensurate with accuracy requirements.

## REFERENCES

- [1] *Guide to the Expression of Uncertainty in Measurement*; ISBN 92-67-10188-9, 1st Ed., ISO, Geneva, Switzerland (1993); see also Taylor, B.N.; Kuyatt, C.E., *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at <http://physics.nist.gov/Pubs/>.
- [2] Levenson, M.S.; Banks, D.L.; Eberhart, K.R.; Gill, L.M.; Guthrie, W.F.; Liu, H.K.; Vangel, M.G.; Yen, J.H.; Zhang, N.F.; *An Approach to Combining Results From Multiple Methods Motivated by the ISO Guide*; J. Res. Natl. Inst. Stand., Vol. 105, pp 571-579 (2000).
- [3] *International Vocabulary of Basic and General Terms in Metrology*; ISBN 92-67-01075-1, 2nd Ed., ISO, Geneva, Switzerland (1993).

<b>Certificate Revision History:</b> 22 December 2003 (This revision reflects an extension in the certification period); 30 November 2000 (Original certificate date).
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*Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet <http://www.nist.gov/srm>.*